

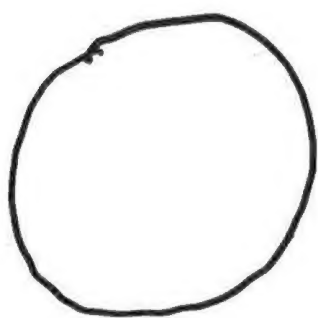
The Invisible World

2.5.01

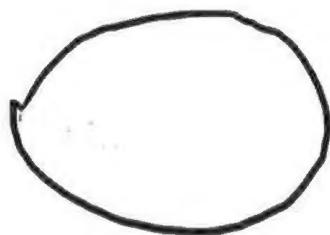
Transparencies

1. Medieval wood cut illustrating the hidden mechanisms of the universe
2. The moon as seen by Galileo.
3. The figure of a bee - Francesco Stelluti, 1625.
4. Spermatozoon - Nicholas Hartsoeker, 1694
5. A bubble chamber - Brookhaven 1964
6. The discovery of the Ω^- particle 1964.
7. Singular structures
8. The singular limit of the vibrating string.
9. The role of Mathematics in physics
10. Desargues' Theorem (1639)
11. Binomial Expansion
12. Ghosts in particle physics.
13. The Tibetan Ghost trap
14. ~~14~~ The Senses and Reality

SINGULAR STRUCTURES



(1)



(2)

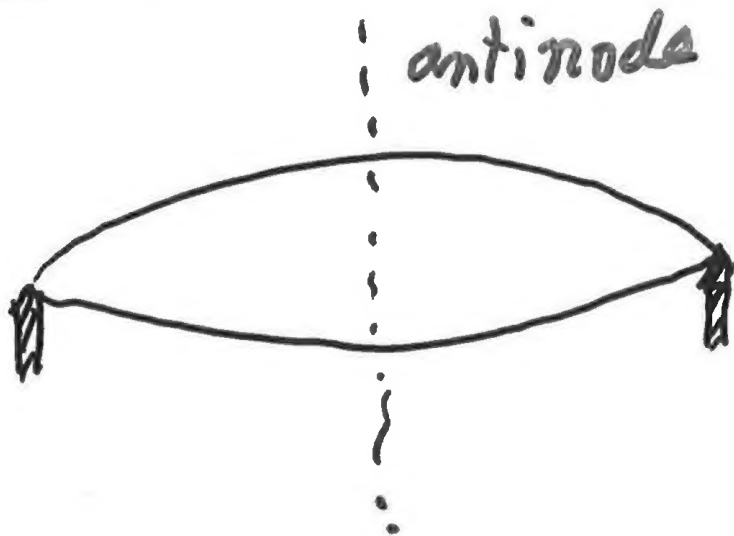


(3)

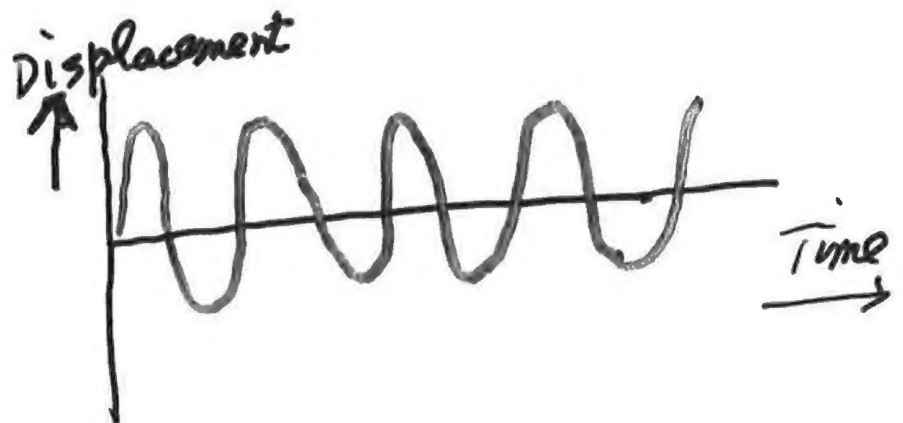


(4)

THE SINGULAR LIMIT OF THE VIBRATING STRING



Finite c

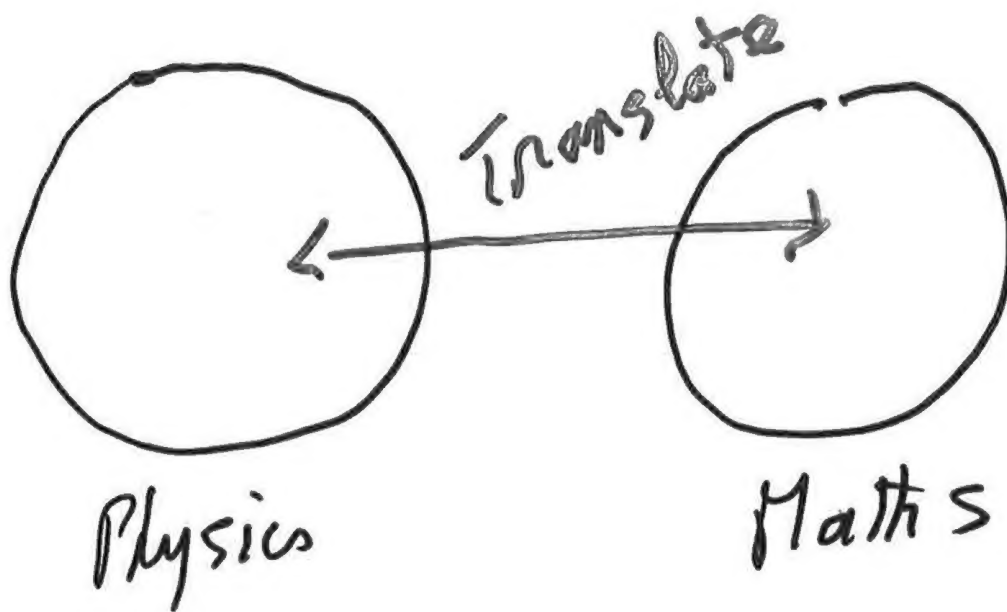


Infinite c

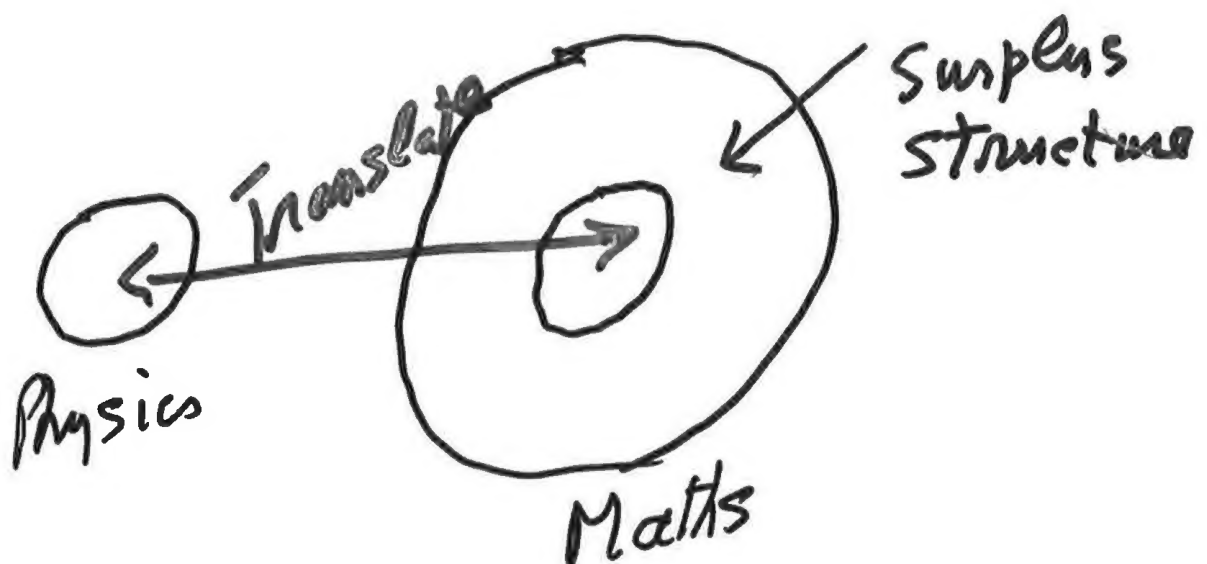


(9)

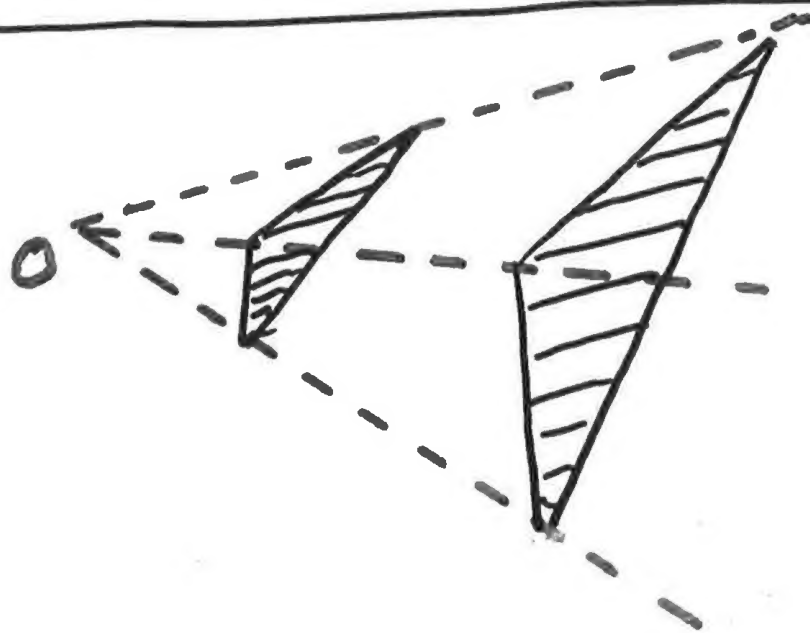
THE RÔLE OF MATHEMATICS IN PHYSICS



SURPLUS STRUCTURE



DESARGUES'S THEOREM



→ another (dual) property

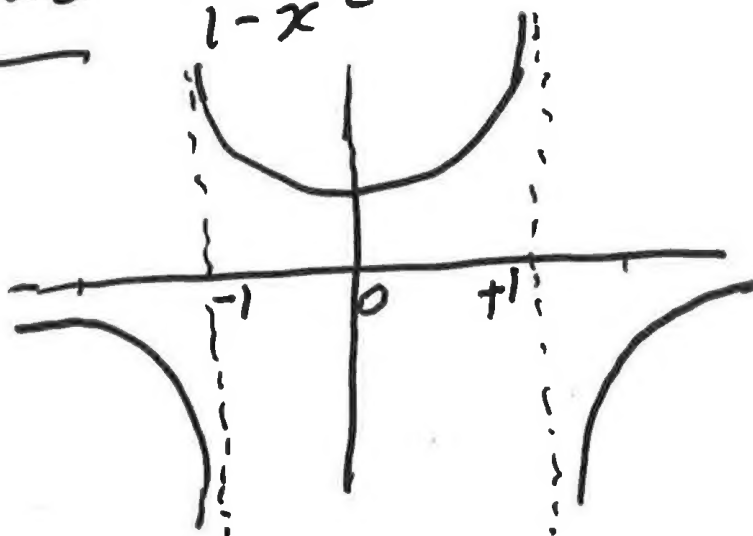
More precisely:

Two triangles which are in perspective with respect to a point are also in perspective with respect to a line.

BINOMIAL EXPANSIONS

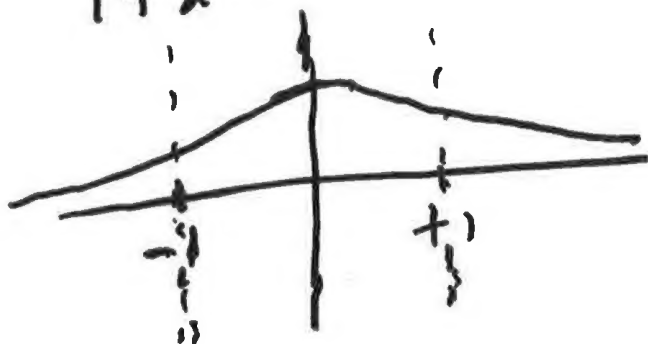
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Compare $\frac{1}{1-x^2} = 1 + x^2 + x^4 + \dots$



Convergence fails for $|x| \geq 1$
due to singular behaviour at $x = \pm 1$

and $\frac{1}{1+x^2} = 1 - x^2 + x^4 - \dots$



Convergence in this case fails for $|x| \geq 1$
due to singular behaviour in the
complex plane at $\pm \sqrt{-1}$.

15.6 Ghosts

25

Section 9.5, the determinant of any matrix $\mathcal{F}_{\alpha x, \beta y}$ may be expressed as a path integral

$$\text{Det } \mathcal{F} \propto \int \left[\prod_{\alpha, x} d\omega_{\alpha}^*(x) \right] \left[\prod_{\alpha, x} d\omega_{\alpha}(x) \right] \exp(iI_{GH}), \quad (15.6.1)$$

where

$$I_{GH} \equiv \int d^4x d^4y \, \omega_{\alpha}^*(x) \omega_{\beta}(y) \mathcal{F}_{\alpha x, \beta y}. \quad (15.6.2)$$

Here ω_{α}^* and ω_{α} are a set of independent anticommuting classical variables, and the constant of proportionality is field-independent. (We have to

THE SENSES AND REALITY

(14)

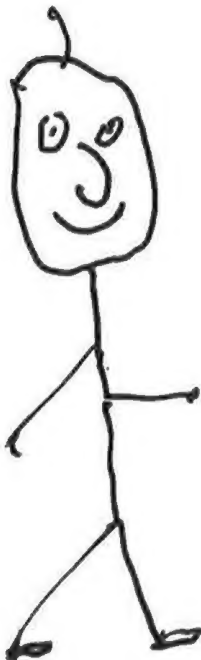
Either



REALITY

The barrier
of the senses

OR



↔
Senses

REALITY